# WATERFOWL FOOD AND HABITAT UTILIZATION ON A SOUTHERN RESERVOIR

A Thesis

by

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May 1976

ABSTRACT

Waterfowl Food and Habitat Utilization on a Southern Reservoir (May 1976)

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A waterfowl food habits and habitat utilization study was done on Lake Somerville, Texas, in the fall, winter and spring of 1974-75 and 1975-76. Six habitat types on the reservoir's upper end were characterized according to topography, vegetation, and physical features. Dramatic changes in waterfowl food plant stands occurred in some areas due to high water levels in summer months during the 2 years of study. Valuable stands of waterfowl food were replaced by annual weeds. Two-hundred forty-one ducks were collected, 182 of which contained food items in their gizzards and esophagi. Twenty-two taxa of food items were identified in the food habits analysis. Principal food items for the first year were smartweed (Persicaria lapathifolia), water and willow oak (Quercus nigra and Q. phellos), water pepper (Persicaria hydropiperoides), marsh-elder (Iva annua), common water-nymph (Najas guadalupensis), and insects. Duck-potato (Sagittaria latifolia), water and willow oak, water hickory (Carya aquatica), primrose-willow (Ludwigia decurrens), and algae were of major importance in the second year. A definite food habits change among the different duck species was noted within the 2 years. Wild mallards had the largest mean volume of food ingested (16.24 cc) but also had the largest standard deviation. Shovelers had the smallest mean volume of food ingested (1.53 cc) and the lowest standard deviation. Grit in wood ducks, green-wing teal, blue-wing teal,

and wigeons was mostly fine sand. Gadwalls contained fine grit exclusively. Pintails and shovelers consumed mostly medium grit. Mallards picked up mostly medium grit but also contained more coarse grit than any other species. Grit size in waterfowl is not necessarily determined by the type or hardness of the food item consumed. Gadwalls had the largest mean volume of grit per gizzard (3.04 cc) and wood ducks had the smallest (0.68 cc). Just over 2 percent of the gizzards and crops contained lead shot. Over-estimates of lead ingestion would have occurred if the investigator had not carefully examined the source of the pellets. Mallards seemed to prefer Flag Pond (a relatively shallow man-made pond in the Lake Somerville flood plain; one of the habitat types) and a greentree reservoir area in the first year. Pintails and wigeons appeared to prefer flooded fields. Most teal, shovelers and gadwalls were observed in Flag Pond in the first year. Wood ducks selected for the greentree reservoir area and lesser scaup preferred open water areas. Movements due to weather and hunting pressure were common in the first year. An area of dead flooded timber received the most utilization in the second year, probably due to the amount of shoreline and abundance of loafing spots. A definite selection among the the different habitat types was noted in 1975-76. Few if any of a population of pen-reared released mallards survived their second year on Lake Somerville. Hunters took heavy tolls and predators probably thwarted any nesting attempts.

# ACKNOWLEDGMENTS

Without the assistance of several persons this study would have been impossible. I would like to recognize these individuals here.

I am indebted to the members of my committee, Drs. B. W. Cain, N. J. Silvy, and J. J. Sperry, for timely advice, criticism and encouragement throughout the project.

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Finally, I would like to dedicate this thesis to my friend and wife, Amy. Her encouragement and love made it all worthwhile.

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# INTRODUCTION

One of the greatest factors affecting the future of North American waterfowl is the problem of diminishing natural habitat. Probably little more than 60 percent of the United States' original 51,395,000 hectares of wetlands remain today (Briggs 1964). These vital areas have succumbed to drainage for purposes of agriculture, land development and flood control. This practice is not localized but includes the extent of waterfowl's yearly range, from northern breeding grounds through migratory routes into critical wintering areas. The pace, though slowing, is sure to continue and from a realistic viewpoint most of these losses are irreversable.

In order to perpetually maintain a waterfowl population equal in numbers to that of today, new suitable habitat must be created at the rate the original is destroyed. This new habitat may be in the form of dug or blasted potholes, man-made lakes, ponds, and marshes, flooded croplands, or green-tree reservoirs. In any case the impoundment or entrapment of water is a necessity.

One particular example of impounded waters, particularly in the South, is flood control and water storage reservoirs. Hundreds of these lakes are scattered across the southern states and many have the potential to serve as wintering areas and rest stops during migration (Johnsgard 1956). In many cases where water levels can be manipulated, their attractiveness to waterfowl can be greatly enhanced.

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The citations of the following pages follow the style of The Journal of Wildlife Management.

Most southern reservoirs were constructed without considering their value to waterfowl so there exists a need to gather information pertaining to waterfowl food and habitat preferences on these impoundments. These data may be used in order to properly plan future reservoirs.

The primary purpose of this study was to evaluate waterfowl food and habitat utilization on Lake Somerville, Texas, a typical southern reservoir. Secondary objectives were to (1) determine habitat preferences between the various duck species, (2) evaluate amount and size of grit ingested by ducks, (3) determine the incidence of lead shot in ducks collected on Lake Somerville, and (4) observe the habits of pen-reared released mallards on Lake Somerville.

## STUDY AREA

Lake Somerville is located in south-central Texas in Washington, Burleson, and Lee counties (Fig. 1). The reservoir was constructed by the Army Corps of Engineers beginning in 1962 by impounding Yegua Creek, a tributary of the Brazos River. The earthfill dam is 7,597 m long, including a 1,437 m dike, and 24 m high. An uncontrolled concrete spillway, 381 m long, is available for emergency runoff. At conservation stage the lake has an area of 4,638 ha and at flood stage the area is 16,107 ha. The mean depth is approximately 4.5 m. The drainage area above the dam is 2,605 sq. km. (Dowell 1964).

Lake Somerville covers a portion of the relatively narrow Yegua Creek flood plain and is surrounded by gently sloping rounded hills. Most of these hills are forested to the water's edge in yaupon (Ilex vomitoria) and post oak (Quercus stellata). The upper end of the reservoir is composed of several habitat types. Marsh-like areas are present as are regions of flooded dead timber. In periods of high water there are inundated fields and also a green-tree reservoir effect along several of the tributaries. This area is shallow and subject to periodic drying and flooding.

The climate of the study area may be characterized as temperate with mild winters and hot summers.

> The late spring and early autumn maximum precipitation periods, coupled with the low winter and low summer precipitation periods, are the climatic patterns of the interior of Texas. The two maximum precipitation periods in May and September are characteristic of the interior, partly because of convective thunderstorm activity and partly because at these two times migrations of cooler air from the north have a good opportunity to encounter well

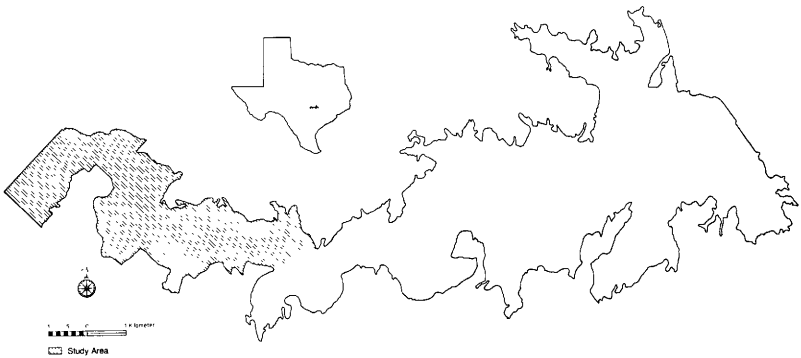


Fig 1 Study area on Lake Somerville, Texas

established moisture-laden winds from the Gulf of Mexico. Also, upper level areas of atmospheric convergence are then moving over Texas from the west and from the east (Carr 1967).

A meterology station operated by the Corps of Engineers is located at the Lake Somerville damsite. The average annual precipitation over an 11 year period is 102.7 cm. Total rainfall in 1974 was 117.6 cm and in 1975 it was 95.6 cm (Table 1). The average annual temperature over a period of 10 years is 19.4 degrees (C). Temperatures of 38 degrees are not uncommon in summer months while temperatures of minus 4 degrees in winter are infrequent. The average annual evaporation rate over a period of 7 years is 184.1 cm (U.S.D.C. Annual Summaries 1965-1974).

The soils in this area are of two main types. They are the Trinity-Kaufman Clays in the bottomlands and Crockett Sandy Loams on the slopes and knolls. The clays are described by Moncrief (1960) as: Trinity Clays-"very dark gray crumbly calcareous surface, 20-40 inches [50.8 cm-101.6 cm] thick, over dark gray firm calcareous clay." Kaufman Clays-"dark gray to black crumbly slightly acid surface, 10-15 inches [25.4 cm-38.1 cm] thick, over dark gray firm subangular blocky non-calcereus clay." The loams are described by Meyer et al. (1913) as "a slightly loamy sand, underlain at about 24-28 inches [60.9 cm-71.1 cm] by a yellow or reddish-yellow friable sandy loam. Chert and iron oxide concretions present throughout soil in small quantities; slightly acid."

Table 1. 1974-1975 precipitation (cm.) recorded at Lake Somerville damsite.

| | 1974 | 1975 |
|---|---|---|
| January | 13.28 | 5.48 |
| February | 0.76 | 2.38 |
| March | 6.85 | 0.99 |
| April | 3.58 | 10.62 |
| May | 9.88 | 20.52 |
| June | 2.71 | 10.54 |
| July | 3.78 | 10.26 |
| August | 18.36 | 3.70 |
| September | 21.53 | 4.97 |
| October | 14.30 | 11.15 |
| November | 17.27 | 3.68 |
| December | 5.25 | 6.09 |

# METHODS

## Vegetation Analysis

The upper portion of the lake was selected as the study area because of its attractiveness to waterfowl, the variety of habitats, fluctuating water levels, and because waterfowl hunting is allowed only in this area of the reservoir. With the aid of aerial photographs, topographic and soil maps, and ground truthing, the upper end of the reservoir is characterized into six habitat types (Fig. 2): (1) Open Water, (2) Nail's Creek, (3) Dead Woods, (4) Green Woods, (5) Flooded Fields, and (6) Flag Pond. Most divisions are made on the basis of topographic features and type of vegetation present.

The point-center-quarter method (Cottam and Curtis 1956) was used to evaluate the vegetation in Green Woods area. Thirty-five randomly selected points were determined by walking a randomly selected number of paces along predetermined compass bearings. Only trees, shrubs and saplings with at least 2.54 cm d.b.h. were sampled. An importance value was derived for each species by summing their respective relative density, relative dominance, and relative frequency.

Vegetation analysis on all other habitat types was strictly qualitative. All aquatics, emergents, weeds (with the exception of some forb and grass species) and woody plants in each habitat type were identified. Relative abundance and the growth patterns of each were noted. Unknown species were collected, pressed, dried and later identified. Changes in vegetation in the 2 years of study were noted. Botanical nomenclature follows Correll and Johnson (1970).

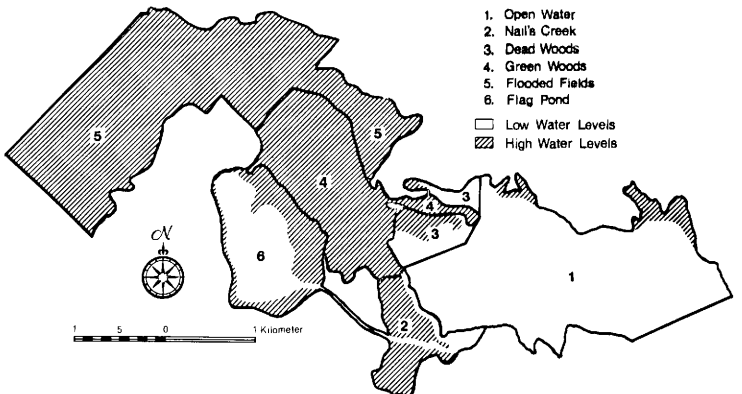


Fig. 2. Habitat types on upper end of Lake Sommerville, Texas

An attempt was made to determine the seed yield of one weed species following the methods of Singleton (1951). Seeds from a pure stand of Iva annua within a 1 sq. m area were collected by hand, air dried, and the chaff was separated in a commercial seed cleaner and separator. The seeds were weighed and a yield in kg/ha was calculated.

Waterfowl Collection

Waterfowl were collected in the legal hunting seasons during both years of this study. The author and two other graduate students collected the majority of the ducks although the gizzard and crop were removed from birds collected by other hunters on several occasions. Ducks were collected from structure-type blinds, natural blinds, and by jump-shooting in all habitat types on the study area. Hunting was conducted throughout the day but most ducks were killed in the early morning and just prior to sunset. A dog was used to retrieve cripples and because of its use, some cripples were also obtained that were shot by other hunters.

Food Habits Analysis

Gizzards and crops were either frozen or placed in solution of 10 percent formalin and labeled by species, date collected, and habitat type. Gizzard and crop contents were removed later and placed separately in a solution of 40 percent ethyl alcohol. Each gizzard and corresponding crop were analyzed together. Total volume of the contents from each crop and gizzard was measured by water displacement. These contents were placed into a gridded petri dish and the grit separated from the

food items.

The food items were separated and identified with the aid of a reference collection made on the study area. A list of known waterfowl food plants was also constructed and this list was compared to vegetation on the study area. Seeds from plants found on both lists were collected and preserved as were seeds from plants abundant on the study area but not found on the waterfowl food plants list. Plant materials were identified to species when possible and animal materials were identified to class. Samples of all food items found were preserved and stored.

The food items were listed by aggregate volume rather than aggregate percentage (Swanson et al. 1974) because gizzards and crops varied in size and feeding intensity was not observed prior to collecting. An importance value was calculated by multiplying aggregate volume times frequency of occurrence (McCaffery et al. 1974). Frequency of occurrence is defined as the number of birds that consume a particular food item divided by the number of birds in the sample.

The average volume of food items per gizzard and esophagus was calculated for each species. Gizzards and esophagi containing less than 1 cc of food items were omitted.

Grit and Lead Shot Analysis

Two hundred and seven ducks were analyzed for amount and size of grit ingested. The grit from each gizzard and crop was placed into one of six categories: (1) fine (less than 1.5mm dia.), (2) fine-medium, (3) medium (greater than or equal to 1.5mm dia. and less than 3mm dia.),

(4) medium-coarse, (5) coarse (greater than 3mm dia.), or (6) fine-medium-coarse (fine and medium and coarse). Average volume and standard deviation per species were calculated.

The incidence of lead shot was noted during the food habits analysis. Number and condition of shot per gizzard was noted as was the species of duck in which the shot was found. Gizzards were examined to ensure that the shot found within was not the result of a pellet penetrating the body and entering the gizzard when the bird was shot.

Waterfowl Census

Waterfowl were inventoried weekly during the fall, winter and spring of 1974 to 1976, excluding the legal waterfowl hunting seasons (Sept. 14-22, 1974, Nov. 9-24, 1974, Dec. 9, 1974-Jan. 19, 1975, Sept. 20-28, 1975, Nov. 1-30, 1975, Dec. 20, 1975-Jan. 18, 1976). The time period during the hunting seasons was omitted because it is thought that due to hunting pressure the birds may not have been in preferred habitats. This survey was conducted in a small motor boat and on foot and covered each habitat type thoroughly. Species of waterfowl and abundance of each were recorded for each habitat type. Ducks were counted as accurately as possible but in some cases estimations were necessary because of the large numbers of birds. It is felt that these estimations were sufficiently accurate for this study since trends rather than absolute numbers were the objective. Water depth on each habitat was recorded on each survey. Water level and waterfowl use correlations were noted along with waterfowl movement within the study area.

Twenty-one waterfowl surveys were conducted during the first season

and data from 13 of these were used in the habitat utilization analysis. Eight surveys were in the second seasons analysis. These surveys were chosen on the basis of thoroughness of the survey and human intervention. In some cases surveys were omitted if it was felt that some ducks were uncounted or counted twice. Surveys were omitted if on that date, fishermen or other persons were present on the study area because their presence may affect waterfowl habitat selection. The number of ducks in each habitat type was summed from the selected surveys and expressed as a percentage of this total. Due to frequent and drastic water fluctuations, a statistical analysis was not applied to the first year's data. On some survey dates, more of a particular habitat type was available than on others. However, a minimum of 5 ha of each habitat type was available in all of the selected surveys of the first year.

Lake elevations were stable throughout the second season of study and the size of each habitat type was constant. Flooded Fields were not available as habitat, and only the Yegua Creek portion of Green Woods area could be utilized by waterfowl. A Chi-square analysis was used to determine if the ducks were selecting between Flag Pond, Nail's Creek and Dead Woods. Expected values (number of ducks per habitat type) were calculated in two ways, first according to water surface area in each type, and second, by the amount of shoreline in each habitat type (Table 2). The hypotheses that ducks were not selecting among the different habitat types according to water surface area and amount of shoreline were rejected at the $p=.01$ level of significance.

Table 2. Calculation of expected values for determining waterfowl selection within three habitat types on Lake Somerville, 1975-1976.[a]

| Type | Size | Division Factor | Expected Percentage |
|---|---|---|---|
| Flag Pond | 97.0 ha[b] | 13.1 | 78.9 |
| Nail's Creek | 7.4 ha | 1.0 | 6.0 |
| Dead Woods | 18.6 ha | 2.5 | 15.1 |
| | | 16.6 | 100.0 |
| Flag Pond | 4800 m[c] | 2.4 | 46.6 |
| Nail's Creek | 2000 m | 1.0 | 19.4 |
| Dead Woods | 3500 m | 1.75 | 33.9 |
| | | 5.15 | 99.9 |

[a]Type with smallest size (Nail's Creek in both cases) is assigned a division factor of 1. The other types are expressed as multiples of the smallest. Each division factor divided by the total of the 3 division factors x 100 gives an expected percentage.

[b]Calculated according to water surface area in each habitat.

[c]Calculated according to length of shoreline in each habitat.

## RESULTS AND DISCUSSION

### Habitat Types

Open Water. This region comprises approximately 364 ha of the study area during low lake levels and 396 ha during high levels. The depth varies but averages less than 2.5 m at pool stage. The border of the post oak-yaupon forest is usually no more than 15 m from the water's edge at pool stage. Vegetation in this type is limited to grasses along the shoreline, an occasional small clump of bulrush (Scirpus sp.) and free-floating algae. No significant changes in vegetation were noted within the 2 years of study.

Nail's Creek. At pool stage the Nail's Creek region is a series of shallow meandering sloughs and potholes which covers 7.3 ha and averages less than 0.5 m in depth. Woody vegetation includes black willow (Salix nigra), along some of the sloughs, and scattered deciduous holly (Ilex decidua). Low ground cover includes Bermuda grass (Cynodon dactylon), yellow nut-grass (Cyperus esculentus), greenbriar (Smilax sp.), chicken spike (Sphenoclea zeylanica), pigweed (Amaranthus albus), leaf-flower (Phyllanthus caroliniensis), common balloon-vine (Cardiospermum halicacabum), tooth-cup (Ammannia coccinea), and primrose-willow (Ludwigia decurrens). Dense mats of water-hyssop (Bacopa rotundifolia) have formed in the shallows.

Dramatic changes in dominant vegetation occurred during the two years of study. During the 1974-75 season dense stands of smartweed (Persicaria lapathifolia) and water pepper (Persicaria hydropiperoides) covered the entire area. These were almost entirely replaced with

coffee senna (Cassia occidentalis) the following year. Also, an abundant growth of duck-potato (Sagittaria latifolia) was present in the 1975-76 season but not in the previous year.

The area of this habitat type increases in size to approximately 48 ha during high water levels. At this time an old-field area is inundated to depths of 1.5 m. Smartweed was the dominant vegetation here in 1974-75 but was replaced the next year by wooly croton (Croton capitatus) and coffee senna. Ground cover is predominantly Bermuda grass.

Dead Woods. This habitat was formed by permanently flooding bottomlands hardwoods. It is an area of standing dead timber, floating and submerged stumps and logs, intertwinded with wandering creek channels. It comprises approximately 18.6 ha at low lake levels and averages less than 1 m in depth. Buttonbush (Cephalanthus occidentalis), water elm (Planera aquatica), and deciduous holly are the predominant live woody vegetation. Non-woody plants include primrose-willow, yellow nut-grass, common hornwort (Ceratophyllum demersum), and rattlebush (Sesbania drummondii). Coffee senna replaced smartweed and water pepper during the second year of study and duck-potato replaced common water-nymph (Najas guadalupensis). During high water this habitat increases in size to 41 ha.

Green Woods. This area comprises a portion of Yegua Creek and approximately 197 ha of bottomland hardwoods. With the exception of the creek channel this type is not available as waterfowl habitat except in periods of high water. The water depth in the woods may then reach 1 m.

Cedar elm (Ulmus crassifolia), white ash (Fraxinus americana), and water hickory (Carya aquatica) had the highest importance values in this area (Table 3). Vines include greenbriar, wild grape (Vitis sp.), rattan (Berchemia scandens), and trumpet-creeper (Campsis radicans). Some small forbs are present. Stands of jungle-rice (Echinochloa colonum) are scattered along Yegua Creek. No significant changes in vegetation were noted between 1974 and 1976.

Flooded Fields. This area is available as waterfowl habitat only in periods of high water levels and may comprise as much as 430 ha. The depth averages approximately 0.5 m. This type existed as domestic pasture before the construction of the reservoir. Since federal acquisition of the floodplain, the fields have gone predominantly to weeds. Vast stands of marsh-elder (Iva annua) are present over much of this region. Smart-weed and water pepper are common in low sections. Sedges (Carex crus-corvi, Carex cherokeensis), grasses (Bromus uniloides, Echinochloa walteri), fleabane (Erigeron sp.), heliotrope (Heliotropium indicum), palmetto (Sabal minor), and coffee senna are also present. Trees include scattered individuals of honey mesquite (Prosopis glandulosa), live oak (Quercus virginiana), and white ash. No change in vegetation composition was noted in this two-year study.

Flag Pond. This region is unique in that it was prime waterfowl habitat long before Lake Somerville was constructed. It was originally a series of shallow oxbows with a maximum depth of 1 m. Around 1945 a private hunting club, which has been organized on this site many years before, constructed an earthen levee around the eastern side of

Table 3. Data from a point-center-quarter analysis of Green Woods area, Lake Somerville, Texas.

| Species | Density #/acre | Dominance $ft^2$/acre | Frequency | Rel. Dens. | Rel. Dom. | Rel. Freq. | Imp. Value |
|---|---|---|---|---|---|---|---|
| Ulmus crassifolia | 87.72 | 38.07 | .80 | 48.57 | 63.99 | 39.60 | 152.16 |
| Fraxinus americana | 32.23 | 8.89 | .42 | 17.85 | 14.94 | 20.79 | 53.58 |
| Carya aquatica | 10.31 | 4.75 | .20 | 5.71 | 7.98 | 9.9 | 23.59 |
| Celtis laevigata | 11.59 | 2.06 | .20 | 6.42 | 3.46 | 9.9 | 19.78 |
| Quercus phellos | 9.03 | 3.78 | .05 | 5.00 | 6.35 | 2.47 | 13.82 |
| Ilex decidua | 3.86 | .03 | .08 | 2.14 | .05 | 3.96 | 6.15 |
| Diospyros virginiana | 5.14 | .08 | .05 | 2.85 | .13 | 2.47 | 5.45 |
| Gleditsia triacanthos | 5.14 | .08 | .05 | 2.85 | .13 | 2.47 | 5.45 |
| Quercus stellata | 3.86 | .15 | .05 | 2.14 | .25 | 2.47 | 4.86 |
| Ulmus americana | 1.28 | 1.39 | .02 | .71 | 2.33 | .99 | 4.03 |
| Planera aquatica | 3.86 | .10 | .02 | 2.14 | .16 | .99 | 3.29 |
| Ulmus alata | 1.28 | .07 | .02 | .71 | .11 | .99 | 1.81 |
| Robina pseudo-acacia | 1.28 | .03 | .02 | .71 | .05 | .99 | 1.75 |
| Crataegus sp. | 1.28 | .006 | .02 | .71 | .01 | .99 | 1.71 |
| Cephalanthus occidentalis | 1.28 | .006 | .02 | .71 | .01 | .99 | 1.71 |

this area. The water area increased to 140 ha with a maximum depth of 1.5 m.

The Flag Pond levee was cut and a canal was dug to connect this region with the main body of Lake Somerville. Since that time, Flag Pond's water elevation has fluctuated with that of the lake. During low water periods the surface area of Flag Pond may decrease to 97 ha.

In 1974 the vegetation of Flag Pond consisted mainly of dense stands of smartweed mixed with water pepper. Also present were rattlebush, common balloon-vine, Bermuda grass, and yellow nut-grass. Wooly croton, deciduous holly, and black willow grew on the levee and ditch spoil. In 1975 smartweed and water pepper were replaced by coffee senna and cocklebur (Xanthium strumarium). Dense growths of duck-potato grew in the shallow water and along the shore in 1975. Water-lilies (Nymphaea sp.) covered the south end of Flag Pond in May 1975 but died out by August of that year.

Within the 2 years of study dramatic changes in dominant vegetation took place in the Flag Pond, Nail's Creek and Dead Woods regions. The first year dominants, smartweed and water pepper, were almost entirely replaced the second year by annual weeds such as coffee senna. Lush growths of duck-potato were abundant the second year but not in the first. This change could be due to several factors.

Martin and Uhler (1939) state that irregular or extreme fluctuation in water levels is the most important single factor in preventing the development of waterfowl feeding grounds.

Low and Bellrose (1944) found that water depth and turbidity were foremost among environmental factors affecting the normal yield of seed

and foliage. Peltier and Welch (1970) found reservoir elevation, rainfall, incident light, and turbidity implicated in the distribution and intensity of aquatic plant growth.

Due to heavy rainfall as much as 3 m of water covered these habitat types in May and June 1975 (Table 4). A minimum depth of 1 m was present in June of that year and this stress came at a critical period in plant development. In addition to the limiting effect of light, seeds and young plants may have been smothered by the deposition of silt (Peltier and Welch 1970). Percival et al. (1970) noted that when fields which could produce water pepper were flooded, they did not usually support this plant.

The influx of weeds came in July after the high water had receded. Due to short germination periods and rapid growth, they were able to cover these areas. If the trend continues, similar to Meeks' (1969) observations, and weeds become established it is probable that the extent of the smartweed and water pepper stands will be greatly reduced.

No specific reasons can be determined for the decline of common water-nymph and dramatic increase in duck-potato during the second year of study. It is probably due to a combination of the previously mentioned factors. Singleton (1965) states that excellent growths of duck-potato occur in reservoirs that are subjected to fluctuating water levels.

Records pertaining to water levels for Lake Somerville are not available for years before 1975. No deductions can be made concerning the conditions which led to the development of the vegetation present in 1974.

Table 4. 1975 Lake Somerville monthly elevations (ft. msl.).[a]

| Month | Low | High |
|---|---|---|
| January | 237.85 | 238.71 |
| February | 238.02 | 242.42 |
| March | 237.97 | 240.45 |
| April | 237.94 | 238.29 |
| May | 238.15 | 246.78 |
| June | 242.80 | 247.08 |
| July | 239.91 | 244.25 |
| August | 237.90 | 239.87 |
| September | 237.80 | 238.16 |
| October | 237.45 | 237.80 |
| November | 237.64 | 237.86 |
| December | 237.62 | 237.84 |

[a]At 238 msl (pool stage) water barely covers all of Flag Pond and Dead Woods. At 241 msl, all of Nail's Creek and Green Woods are inundated along with most of Flooded Fields.

Food Habits

A total of 241 ducks was collected during the hunting seasons of this study. Ninety-seven birds were collected the first year, 86 of which contained food items in amounts sufficient to analyze (at least 1 cc), and 144 ducks were collected the second year, 96 of which contained food items (Table 5). The 86 birds collected the first year contained 373.83 cc of food items. The 96 birds collected the second year contained 642.20 cc of food items. Twenty-two taxa of food items were identified. These composed 93.05 percent of the total volume leaving 6.95 percent as unknown food items.

Listed according to descending importance value (aggregate volume x frequency of occurance), the principal food items for the first year were smartweed, water and willow oak, water pepper, marsh-elder, common water-nymph, and insects (Table 6). Algae, deciduous holly, molluscs, Bermuda grass, wooly croton, American elm, honey mesquite, and crustaceans were of lesser importance. Plant materials made up 93.56 percent of the total volume. The remainder consisted of animal matter.

In descending order, duck-potato, water and willow oak, water hickory, primrose-willow, and algae were of major importance the second year (Table 6). Coffee senna, yellow nut-grass, deciduous holly, insects, molluscs, Bermuda grass, wooly croton, American elm, cedar elm, fish, smartweed, water pepper, common water-nymph, and rattlepod (Crotalaria sp.) were less common in the samples. Ninety-eight percent of these items were plant materials.

Five-hundred sixteen pen-reared mallards were banded and released on Lake Somerville in the spring of 1974 by the Texas Parks and Wildlife

Table 5. Number of waterfowl collected in 1974-75 and 1975-76 hunting seasons, and number of those containing food items in amounts sufficient to analyze (at least 1 cc), Lake Somerville, Texas.

| Species | No. Collected | No. With Food Items |
|---|---|---|
| Wood Duck | | |
| 1974-75 | 7 | 7 |
| 1975-76 | 13 | 13 |
| Released Mallard | | |
| 1974-75 | 12 | 12 |
| 1975-76 | 0 | 0 |
| Wild Mallard | | |
| 1974-75 | 12 | 11 |
| 1975-76 | 9 | 9 |
| Green-wing Teal | | |
| 1974-75 | 19 | 18 |
| 1975-76 | 87 | 52 |
| Blue-wing Teal | | |
| 1974-75 | 9 | 9 |
| 1975-76 | 8 | 2 |
| Pintail | | |
| 1974-75 | 8 | 3 |
| 1975-76 | 3 | 3 |
| Wigeon | | |
| 1974-75 | 9 | 9 |
| 1975-76 | 2 | 2 |
| Gadwall | | |
| 1974-75 | 6 | 6 |
| 1975-76 | 8 | 3 |
| Shoveler | | |
| 1974-75 | 5 | 5 |
| 1975-76 | 12 | 11 |
| Others | | |
| 1974-75 | 10 | 6 |
| 1975-76 | 2 | 1 |
| Total | 241 | 182 |

Table 6. Food items recorded in waterfowl gizzards and esophagi, 1974-75 and 1975-76 hunting seasons, Lake Somerville, Texas.

| Food Item | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value A x B |
|---|---|---|---|
| Persicaria lapathifolia | | | |
| 1974-75 | 11.16 | 65.1 | 727 |
| 1975-76 | 0.23 | 7.3 | 2 |
| Persicaria hydropiperiodes | | | |
| 1974-75 | 8.40 | 52.3 | 439 |
| 1975-76 | 0.23 | 10.4 | 2 |
| Najas guadalupensis | | | |
| 1974-75 | 4.74 | 26.7 | 127 |
| 1975-76 | Tr | 1.0 | -- |
| Quercus phellos & Q. nigra | | | |
| 1974-75 | 36.32 | 15.1 | 548 |
| 1975-76 | 22.43 | 10.4 | 233 |
| Iva annua | | | |
| 1974-75 | 16.90 | 19.7 | 333 |
| 1975-76 | -- | -- | -- |
| Crotalaria sp. | | | |
| 1974-75 | -- | -- | -- |
| 1975-76 | 0.48 | 33.3 | 16 |
| Cassia occidentalis | | | |
| 1974-75 | -- | -- | -- |
| 1975-76 | Tr | 2.0 | -- |
| Cyperus esculentus | | | |
| 1974-75 | -- | -- | -- |
| 1975-76 | 0.45 | 13.5 | 6 |
| Algae | | | |
| 1974-75 | 0.42 | 1.1 | -- |
| 1975-76 | 4.30 | 8.3 | 36 |
| Ludwigia decurrens | | | |
| 1974-75 | -- | -- | -- |
| 1975-76 | 4.75 | 18.7 | 89 |
| Ilex decidua | | | |
| 1974-75 | 0.44 | 9.3 | 4 |
| 1975-76 | 0.29 | 12.5 | 4 |
| Sagittaria latifolia | | | |
| 1974-75 | -- | -- | -- |
| 1975-76 | 34.78 | 56.2 | 1955 |
| Carya aquatica | | | |
| 1974-75 | -- | -- | -- |
| 1975-76 | 23.60 | 9.3 | 219 |

(Continued)

Table 6 (Continued).

| Food Item | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value A x B |
|---|---|---|---|
| Cynodon dactylon | | | |
| 1974-75 | 2.04 | 2.3 | 5 |
| 1975-76 | Tr | 1.0 | -- |
| Croton capitatus | | | |
| 1974-75 | Tr | 1.1 | -- |
| 1975-76 | Tr | 1.0 | -- |
| Ulmus americana | | | |
| 1974-75 | Tr | 1.1 | -- |
| 1975-76 | Tr | 1.0 | -- |
| Prosopis glandulosa | | | |
| 1974-75 | Tr | 1.1 | -- |
| 1975-76 | -- | -- | -- |
| Ulmus crassifolia | | | |
| 1974-75 | -- | -- | -- |
| 1975-76 | 3.73 | 5.8 | 22 |
| Insecta | | | |
| 1974-75 | 5.13 | 24.4 | 125 |
| 1975-76 | 0.33 | 8.3 | 3 |
| Mollusca | | | |
| 1974-75 | 0.40 | 2.3 | 1 |
| 1975-76 | 1.62 | 14.5 | 23 |
| Crustacea | | | |
| 1974-75 | Tr | 1.1 | -- |
| 1975-76 | -- | -- | -- |
| Osteichthyes | | | |
| 1974-75 | -- | -- | -- |
| 1975-76 | Tr | 1.0 | -- |
| Unknown Plant Foods | | | |
| 1974-75 | 14.05 | | |
| 1975-76 | 2.78 | | |

Department as part of a statewide project in an attempt to establish local breeding populations (Leifeste 1975). These released birds were segregated from wild mallards in the food habits portion of this study.

Wood Duck Food Habits. Gizzards and esophagi of 20 wood ducks were examined (Table 7). Seven were collected in the first year and 13 in the second year. Willow and water oak mast was found in every bird in the first year and made up 97.94 percent of the total volume. Smartweed and insects were found in trace amounts.

Water hickory mast replaced that of oak as most important food in the second year. Fruit of water hickory comprised 69.07 percent of the total volume while that of oak dropped to 20.98 percent. Algae, deciduous holly, insects, wooly croton, and cedar elm were found in small amounts in the second year.

Released Mallard Food Habits. Twelve released mallards were analyzed, all collected in the first year (Table 8). Marsh-elder, water pepper, smartweed, and insects were principal food items. Common water-nymph, deciduous holly, Bermuda grass, wooly croton, and acorns were less abundant.

Wild Mallard Food Habits. Gizzards and esophagi of 11 wild mallards collected during the first year and 9 mallards collected in the second year were examined (Table 9). Oak mast made up 75.75 percent of the total volume the first year. The remainder of the known food items that year included water pepper, smartweed, common water-nymph, deciduous holly, Bermuda grass, and insects.

Duck-potato replaced oak mast in importance the second year. Duck-

Table 7. Food items recorded in wood duck gizzards and esophagi, 1974-75 and 1975-76 hunting seasons, Lake Somerville, Texas.

| Food Item | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value |
|---|---|---|---|
| Persicaria lapathifolia | | | |
| 1st year | Tr | 14.28 | -- |
| 2nd year | -- | -- | -- |
| Quercus nigra & Q. phellos | | | |
| 1st year | 97.94 | 100.00 | 9794 |
| 2nd year | 20.98 | 46.15 | 968 |
| Algae | | | |
| 1st year | -- | -- | -- |
| 2nd year | 1.65 | 7.69 | 13 |
| Ilex decidua | | | |
| 1st year | -- | -- | -- |
| 2nd year | 0.24 | 7.69 | 2 |
| Insecta | | | |
| 1st year | 1.54 | 14.28 | 22 |
| 2nd year | 0.24 | 15.38 | 4 |
| Carya aquatica | | | |
| 1st year | -- | -- | -- |
| 2nd year | 69.07 | 69.23 | 4781 |
| Croton capitatus | | | |
| 1st year | -- | -- | -- |
| 2nd year | 0.10 | 7.69 | 1 |
| Ulmus crassifolia | | | |
| 1st year | -- | -- | -- |
| 2nd year | 4.79 | 23.07 | 110 |
| Unknown plant foods | | | |
| 1st year | 0.52 | | |
| 2nd year | 2.93 | | |

Table 8. Food items recorded in released mallard gizzards & esophagi, 1974-75 hunting season, Lake Somerville, Texas.

| Food Item | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value A x B |
|---|---|---|---|
| Persicaria lapathifolia | 8.85 | 58.33 | 516 |
| Persicaria hydropiperoides | 13.88 | 66.66 | 925 |
| Najas gradalupensis | 0.23 | 8.33 | 2 |
| Iva annua | 36.28 | 50.00 | 1814 |
| Ilex decidua | 1.9 | 41.66 | 79 |
| Cynodon dactylon | 5.22 | 8.33 | 43 |
| Croton capitatus | 0.11 | 8.33 | 1 |
| Quercus nigra & Q. phellos | 3.76 | 8.33 | 31 |
| Insecta | 6.38 | 33.33 | 213 |
| Unknown plant foods | 23.39 | | |

Table 9. Food items recorded in wild mallard gizzards & esophagi, 1974-75 and 1975-76 hunting seasons, Lake Somerville, Texas.

| Food Item | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value A x B |
|---|---|---|---|
| Persicaria lapathifolia | | | |
| 1st year | 1.13 | 45.45 | 51 |
| 2nd year | Tr | 11.11 | -- |
| Persicaria hydropiperoides | | | |
| 1st year | 9.87 | 81.81 | 807 |
| 2nd year | Tr | 22.22 | -- |
| Najas guadalupensis | | | |
| 1st year | 0.2 | 18.18 | 4 |
| 2nd year | -- | -- | -- |
| Quercus nigra & Q. phellos | | | |
| 1st year | 75.76 | 45.45 | 3443 |
| 2nd year | 41.91 | 44.44 | 1862 |
| Crotalaria sp. | | | |
| 1st year | -- | -- | -- |
| 2nd year | Tr | 33.33 | -- |
| Algae | | | |
| 1st year | -- | -- | -- |
| 2nd year | Tr | 11.11 | -- |
| Ilex decidua | | | |
| 1st year | 0.12 | 18.18 | 2 |
| 2nd year | 0.23 | 14.44 | 10 |
| Sagittaria latifolia | | | |
| 1st year | -- | -- | -- |
| 2nd year | 53.07 | 55.55 | 2948 |
| Cynodon dactylon | | | |
| 1st year | 3.88 | 9.09 | 35 |
| 2nd year | -- | -- | -- |
| Ulmus crassifolia | | | |
| 1st year | -- | -- | -- |
| 2nd year | 3.12 | 11.11 | 35 |
| Insecta | | | |
| 1st year | 0.74 | 9.09 | 7 |
| 2nd year | 0.41 | 11.11 | 5 |
| Mollusca | | | |
| 1st year | -- | -- | -- |
| 2nd year | 0.86 | 22.22 | 19 |
| Unknown plant foods | | | |
| 1st year | 8.30 | | |
| 2nd year | 0.40 | | |

potato comprised 53.07 percent of the volume and oak decreased to 41.97 percent. Smartweed, water pepper, rattlepod, algae, deciduous holly, cedar elm, insects, and molluscs were also present.

Green-wing Teal Food Habits. Food habits of 70 green-wing teal were determined (Table 10). Eighteen were collected in the first year and 52 in the second year. Smartweed, water pepper, and common water-nymph made up 67.98 percent of the first year volume. Marsh-elder, insects, and molluscs were less important.

Duck-potato comprised 53.89 percent of the volume in the second year and smartweed, water pepper, and common water-nymph declined to insignificant amounts. Rattlepod, yellow nut-grass, algae, primrose-willow, deciduous holly, American elm, cedar elm, and insects were also present in small amounts in the second year.

Blue-wing Teal Food Habits. Eleven blue-wing teal gizzards and esophagi were examined (Table 11). Nine were killed during the first year of study and two in the second year. Eighty-seven percent of the first year volume was comprised of smartweed, common water-nymph, and marsh-elder. Water pepper and insects were found in smaller amounts. Both birds killed in the second year contained duck-potato which made up 66.18 percent of their total volume.

Pintail Food Habits. Six pintails were analyzed, three being collected during each year of the study (Table 12). Marsh-elder comprised 86.27 percent of the first year volume. The remainder of known food items included smartweed, water pepper, deciduous holly, honey mesquite, and crustaceans.

Table 10. Food items recorded in green-wing teal gizzards & esophagi, 1974-75 and 1975-76 hunting seasons, Lake Somerville, Texas.

| Food Item | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value A x B |
|---|---|---|---|
| Persicaria lapathifolia | | | |
| 1st year | 22.03 | 72.22 | 1591 |
| 2nd year | 1.08 | 3.84 | 4 |
| Persicaria hydropiperoides | | | |
| 1st year | 21.75 | 66.66 | 1450 |
| 2nd year | 0.95 | 11.53 | 11 |
| Najas guadalupensis | | | |
| 1st year | 24.20 | 50.00 | 1210 |
| 2nd year | Tr | 1.92 | -- |
| Iva annua | | | |
| 1st year | 6.61 | 11.11 | 73 |
| 2nd year | -- | -- | -- |
| Crotalaria sp. | | | |
| 1st year | -- | -- | -- |
| 2nd year | 1.17 | 38.46 | 45 |
| Cyperus esculentus | | | |
| 1st year | -- | -- | -- |
| 2nd year | 2.26 | 25.00 | 57 |
| Algae | | | |
| 1st year | -- | -- | -- |
| 2nd year | 8.27 | 7.69 | 64 |
| Ludwigia decurrens | | | |
| 1st year | -- | -- | -- |
| 2nd year | 23.23 | 32.69 | 759 |
| Ilex decidua | | | |
| 1st year | -- | -- | -- |
| 2nd year | Tr | 1.92 | -- |
| Sagittaria latifolia | | | |
| 1st year | -- | -- | -- |
| 2nd year | 53.89 | 67.30 | 3627 |

(Continued)

Table 10. (Continued)

| Food Item | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value A x B |
|---|---|---|---|
| Ulmus americana | | | |
| 1st year | -- | -- | -- |
| 2nd year | 0.10 | 1.92 | -- |
| Ulmus crassifolia | | | |
| 1st year | -- | -- | -- |
| 2nd year | 4.80 | 1.92 | 9 |
| Insecta | | | |
| 1st year | 3.74 | 33.33 | 125 |
| 2nd year | .47 | 5.76 | 3 |
| Mollusca | | | |
| 1st year | 0.15 | 5.55 | 1 |
| 2nd year | -- | -- | -- |
| Unknown plant foods | | | |
| 1st year | 21.52 | | |
| 2nd year | 3.78 | | |

Table 11. Food items recorded in blue-wing teal gizzards and esophagi, 1974-75 and 1975-76 hunting seasons, Lake Somerville, Texas.

| Food Item | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value A x B |
|---|---|---|---|
| Persicaria lapathifolia | | | |
| 1st year | 43.94 | 88.88 | 3905 |
| 2nd year | Tr | 50.00 | -- |
| Persicaria hydropiperoides | | | |
| 1st year | 1.78 | 44.44 | 79 |
| 2nd year | -- | -- | -- |
| Najas guadalupensis | | | |
| 1st year | 20.28 | 44.44 | 901 |
| 2nd year | -- | -- | -- |
| Iva annua | | | |
| 1st year | 23.45 | 11.11 | 260 |
| 2nd year | -- | -- | -- |
| Sagittaria latifolia | | | |
| 1st year | -- | -- | -- |
| 2nd year | 66.18 | 100.00 | 6618 |
| Insecta | | | |
| 1st year | 1.98 | 33.33 | 66 |
| 2nd year | -- | -- | -- |
| Mollusca | | | |
| 1st year | -- | -- | -- |
| 2nd year | Tr | 50.00 | -- |
| Unknown plant foods | | | |
| 1st year | 8.57 | | |
| 2nd year | 33.82 | | |

Table 12. Food items recorded in pintail gizzards and esophagi, 1974-75 and 1975-76 hunting seasons, Lake Somerville, Texas.

| Food Items | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value A x B |
|---|---|---|---|
| Persicaria lapathifolia | | | |
| 1st year | 0.24 | 66.66 | 16 |
| 2nd year | -- | -- | -- |
| Persicaria hydropiperoides | | | |
| 1st year | 6.14 | 100.00 | 614 |
| 2nd year | 0.52 | 33.33 | 17 |
| Iva annua | | | |
| 1st year | 86.27 | 100.00 | 8627 |
| 2nd year | -- | -- | -- |
| Crotalaria sp. | | | |
| 1st year | -- | -- | -- |
| 2nd year | 0.52 | 33.33 | 17 |
| Algae | | | |
| 1st year | -- | -- | -- |
| 2nd year | 43.25 | 33.33 | 1442 |
| Ilex decidua | | | |
| 1st year | 0.20 | 33.33 | 7 |
| 2nd year | -- | -- | -- |
| Sagittaria latifilia | | | |
| 1st year | -- | -- | -- |
| 2nd year | 54.71 | 66.66 | 3647 |
| Prosopis glandulosa | | | |
| 1st year | 1.09 | 33.33 | 36 |
| 2nd year | -- | -- | -- |
| Mollusca | | | |
| 1st year | -- | -- | -- |
| 2nd year | Tr | 33.33 | -- |
| Crustacea | | | |
| 1st year | Tr | 33.33 | -- |
| 2nd year | -- | -- | -- |
| Unknown plant foods | | | |
| 1st year | 6.06 | | |
| 2nd year | 1.00 | | |

Algae and duck-potato made up 97.96 percent of the second year volume. Water pepper, rattlepod, and molluscs were also present in the second year.

American Wigeon Food Habits. Foods of nine American wigeons collected during the first year of study were identified (Table 13). Smartweed, insects, and marsh-elder made up over 70 percent of the total volume. Water pepper and common water-nymph were less common.

Two wigeons were collected in the second year. Both contained duck-potato which made up 99.48 percent of their volume.

Gadwall Food Habits. Six gadwalls were collected during the first year of the study (Table 14). Smartweed, algae, and common water-nymph were prominent food items. Water pepper, marsh-elder, American elm, and insects were also present. Unknown plant foods comprised 60.32 percent of the total first year volume.

Three gadwalls were analyzed in the second year. Duck-potato and algae made up 99.99 percent of their volume.

Shoveler Food Habits. Common water-nymph comprised 74.29 percent of the volume of food in five shovelers killed in the first year (Table 15). Smartweed, water pepper, and insects were less abundant.

Eleven shovelers were collected during the second year of the study. Molluscs and duck-potato were the most important food items. Smartweed, water pepper, rattlepod, coffee senna, primrose-willow, deciduous holly, Bermuda grass, insects, and fish were also present in the gizzards and esophagi during the second year.

Table 13. Food items recorded in American wigeon gizzards and esophagi, 1974-75 and 1975-76 hunting seasons, Lake Somerville, Texas.

| Food Items | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value A x B |
|---|---|---|---|
| Persicaria lapathifolia | | | |
| 1st year | 26.01 | 88.88 | 2312 |
| 2nd year | -- | -- | -- |
| Persicaria hydropiperoides | | | |
| 1st year | 7.4 | 33.33 | 247 |
| 2nd year | -- | -- | -- |
| Najas guadalupensis | | | |
| 1st year | 1.9 | 22.22 | 42 |
| 2nd year | -- | -- | -- |
| Iva annua | | | |
| 1st year | 25.47 | 44.44 | 1132 |
| 2nd year | -- | -- | -- |
| Crotalaria sp. | | | |
| 1st year | -- | -- | -- |
| 2nd year | Tr | 50.00 | -- |
| Sagittaria latifolia | | | |
| 1st year | -- | -- | -- |
| 2nd year | 99.48 | 100.00 | 9948 |
| Insecta | | | |
| 1st year | 20.68 | 22.22 | 460 |
| 2nd year | -- | -- | -- |
| Unknown plant foods | | | |
| 1st year | 18.54 | | |
| 2nd year | 0.52 | | |

Table 14. Food items recorded in gadwall gizzards and esophagi, 1974-75 and 1975-76 hunting seasons, Lake Somerville, Texas.

| Food Items | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value A x B |
|---|---|---|---|
| Persicaria lapathifolia | | | |
| 1st year | 15.30 | 33.33 | 510 |
| 2nd year | -- | -- | -- |
| Persicaria hydropiperoides | | | |
| 1st year | Tr | 16.66 | -- |
| 2nd year | -- | -- | -- |
| Najas guadalupensis | | | |
| 1st year | 6.09 | 16.66 | 101 |
| 2nd year | -- | -- | -- |
| Iva annua | | | |
| 1st year | Tr | 16.66 | -- |
| 2nd year | -- | -- | -- |
| Algae | | | |
| 1st year | 11.93 | 16.66 | 199 |
| 2nd year | 42.16 | 33.33 | 1405 |
| Sagittaria latifolia | | | |
| 1st year | -- | -- | -- |
| 2nd year | 57.83 | 66.66 | 3855 |
| Ulmus americana | | | |
| 1st year | 2.70 | 16.66 | 45 |
| 2nd year | -- | -- | -- |
| Insecta | | | |
| 1st year | 3.66 | 16.66 | 61 |
| 2nd year | -- | -- | -- |
| Unknown plant foods | | | |
| 1st year | 60.32 | | |
| 2nd year | 0.01 | | |

Table 15. Food items recorded in shoveler gizzards and esophagi, 1974-75 and 1975-76 hunting seasons, Lake Somerville, Texas.

| Food Items | Aggregate Vol. (Percent) A | Freq. of Occur. (Percent) B | Imp. Value A x B |
|---|---|---|---|
| Persicaria lapathifolia | | | |
| 1st year | 8.38 | 80.00 | 670 |
| 2nd year | 0.75 | 27.27 | 20 |
| Persicaria hydropiperoides | | | |
| 1st year | 0.67 | 20.00 | 13 |
| 2nd year | Tr | 9.09 | -- |
| Najas guadalupensis | | | |
| 1st year | 74.29 | 80.00 | 5943 |
| 2nd year | -- | -- | -- |
| Crotalaria sp. | | | |
| 1st year | -- | -- | -- |
| 2nd year | 3.87 | 54.54 | 211 |
| Cassia occidentalis | | | |
| 1st year | -- | -- | -- |
| 2nd year | 2.13 | 18.18 | 39 |
| Ludwigia decurrens | | | |
| 1st year | -- | -- | -- |
| 2nd year | 3.16 | 9.09 | 29 |
| Ilex decidua | | | |
| 1st year | -- | -- | -- |
| 2nd year | 4.55 | 54.54 | 248 |
| Sagittaria latifolia | | | |
| 1st year | -- | -- | -- |
| 2nd year | 23.10 | 54.54 | 1260 |
| Cynodon dactylon | | | |
| 1st year | -- | -- | -- |
| 2nd year | 0.93 | 9.09 | 8 |
| Insecta | | | |
| 1st year | 13.55 | 20.00 | 271 |
| 2nd year | Tr | 18.18 | -- |
| Mollusca | | | |
| 1st year | -- | -- | -- |
| 2nd year | 46.67 | 90.90 | 4242 |
| Osteichthyes | | | |
| 1st year | -- | -- | -- |
| 2nd year | 2.08 | 9.09 | 19 |
| Unknown plant foods | | | |
| 1st year | 3.11 | | |
| 2nd year | 12.76 | | |

Other Waterfowl Food Habits. "Other waterfowl" consist of three redheads, one canvasback, one common merganser and two ruddy ducks. All but one redhead were collected during the first year of study. Smartweed was prominent in the volume of the first year birds. Water pepper, insects, and molluscs were also present. Rattlepod made up 95 percent of the food volume in the redhead collected in the second year.

Wild mallards averaged the largest volume of food ingensted (16.246 cc) but also had the largest standard deviation (28.047) (Table 16). Shovelers had the smallest mean volume of food ingested (1.536 cc) and also the lowest standard deviation (0.857).

A definite change in food habits in response to changing vegetation and lake elevations was noted within the 2 years of study for most species. In general, smartweed, water pepper, common water-nymph, oak mast, marsh-elder, and insects were the most important foods in the first year. In the second year, duck-potato, oak and hickory mast were prominant.

Martin and Uhler (1951) rate the achenes of smartweed as excellent waterfowl food and those of water pepper as good. Waterfowl used the dense stands of these plants extensively during periods of high water in the first year of study on Lake Somerville. Most utilization occurred when water depths were deeper than that which is usually considered optimum for puddle ducks (Neely and Davison 1966). Peak numbers of waterfowl occurred in Flag Pond when the depth was 0.66 m to 1.66 m in the stands of smartweed (Fig. 3). Smartweed grew to a height of 2.5 m and most seeds formed near the tops of the plants. The deep water allowed the ducks to strip the seeds from the plant. This allowed earlier utilization of these plants.

Table 16. Average volume and standard deviation of food items found in waterfowl gizzards and crops, 1974-75 and 1975-76 hunting seasons, Lake Somerville, Texas.

| Species | Average Volume (cc.'s) | Standard Deviation s |
|---|---|---|
| Wood Duck | 14.232 | 12.317 |
| Released Mallard | 6.540 | 4.306 |
| Wild Mallard | 16.246 | 28.047 |
| Green-wing Teal | 2.306 | 1.441 |
| Blue-wing Teal | 1.864 | 1.119 |
| Pintail | 8.345 | 5.272 |
| Wigeon | 3.601 | 3.021 |
| Gadwall | 1.927 | .975 |
| Shoveler | 1.536 | .857 |
| Others | 2.051 | 1.197 |
| | 5.59 | 11.435 |

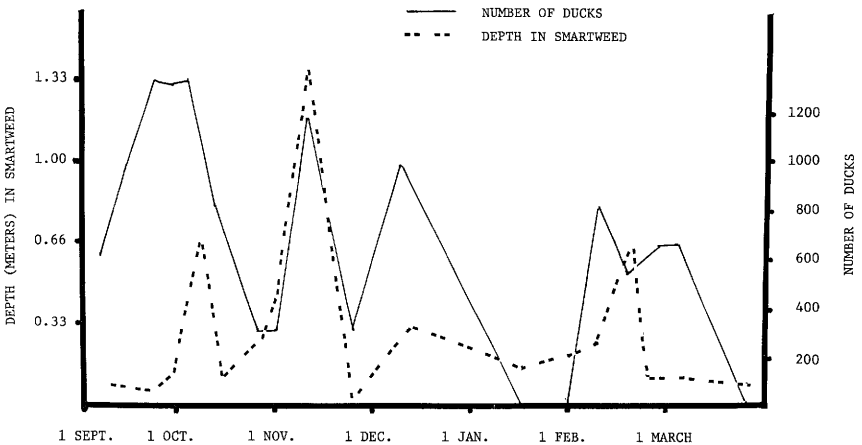


Fig. 3. Total numbers of ducks in Flag Pond as related to water depth in smartweed stands, 1974-75.

Singleton (1951) found water pepper to produce 651.8 kg of air-dried seeds per ha on the Texas gulf coast. Due to the abundance of seeds and their resistance to rot (Shearer et al. 1969) waterfowl continued to utilize the stands of water pepper and smartweed until migrating north in the first year of the study.

Even if the dense stands of water pepper and smartweed had been present on the study area in the second season, it is highly unlikely that they would have achieved their former importance. The stands would not have flooded and thus been inaccessable to most waterfowl.

The status of duck-potato as a waterfowl food plant is controversial. Some authors (Neely and Davison 1966) state that it is seldom used and should be destroyed in favor of better foods. Others (Singleton 1965, Martin et al. 1951) list duck-potato as excellent waterfowl food. The tubers are listed as the most frequently used part of the plant while seed utilization is stated as slight or insignificant (Martin et al. 1951, Martin and Uhler 1939 and McAtee 1939).

This study shows that the seeds of duck-potato can be extremely important as waterfowl food on a local level. Over one-half of all ducks analyzed from the second year contained duck-potato seeds which comprised 34.78 percent of the volume of all food items for that year. All species of waterfowl except wood duck consumed duck-potato seeds and no tubers were eaten. Due to the soft mud bottom most tubers, buried at least 7 cm, are not available (Martin et al. 1951).

Duck-potato was abundant in shallow water and along the shore in the second year. Wind and wave action often concentrated the released seeds into dense floating mats during early September and these mats

offered ready food for many ducks. Duck-potato was scarce on the area during the first year of the study and none was found in ducks killed that year.

Acorns of water and willow oak were listed as excellent waterfowl foods by Martin and Uhler (1939). McGilvrey (1966) found oak mast to comprise over one-half of the volume of wood duck foods in South Carolina. Acorns made up 91.3 percent of the dry-weight volume of wood duck foods and 86.3 percent of the dry-weight volume of mallard foods in an Illinois greentree reservoir (Sweet 1976).

When conducting the food habits analysis for this study, data for willow oak and water oak were combined. Due to advanced stages of digestion, the two species of acorns could not be distinguished in many cases. However, willow oak probably received the most utilization as it was much more abundant on the study area.

All wood ducks collected during the first year contained acorns. Acorns comprised 75 percent of the volume in wild mallards in the first year but made up less than 4 percent of the volume of released mallards.

On many occasions during the first year mallards and wood ducks were seen feeding in the oak flats in the Green Woods area. This area did not flood in the second season and acorn utilization dropped off sharply. Wood ducks switched to water hickory as a staple food and mallards turned to duck-potato. Water hickories lined the banks of Yegua Creek and a considerable portion of their mast fell into the creek allowing easy foraging by the wood ducks. Some dry-land feeding on oak and hickory mast probably occurred during the second year although none was observed.

The nutlets, leaves and stems of common water-nymph were rated as excellent waterfowl foods by Martin and Uhler (1939). McAtee (1939) notes 4,750 seeds of this plant found in one ruddy duck. Waterfowl, especially teals and shovelers, utilized water-nymph extensively during the first year of study. Seeds and vegetative parts of the plants were consumed. Water-nymph was found only in trace amounts in the second season due to the scarcity of the plant that year.

Little has been written concerning the value of marsh-elder as a waterfowl food. Dillon (1959) listed the genus Iva as an inferior food for mallards in south Louisiana. Martin and Uhler (1939) mentioned a similar species as having slight utilization on the Atlantic coast. Marsh-elder is usually considered a pest and a quick invader of unkept land in parts of south-central Texas.

Vast stands of marsh-elder were present in the Flooded Fields area during both years of the study, however they were flooded and accessable to waterfowl only during the first season. At this time they were extensively utilized, especially by pintails, wigeons, and released mallards. Only the seeds were consumed. No evidence of marsh-elder was found in the wild mallards.

An attempt to determine the seed production of marsh-elder resulted in a yield of 669.7 kg per ha. This air-dried seed yield is probably low because some seeds had fallen before the samples were taken.

Primrose-willow has been listed as an important waterfowl food by Martin and Uhler (1939). McAtee (1939) noted a record of 115,000 seeds of this plant found in the gizzard and crop of one mallard. One-third of all green-wing teal analyzed in the second year contained seeds of

primrose-willow. Shovelers utilized the seeds to a lesser extent.

Algae achieved significance as a duck food in the second season. Gadwalls and pintails were the prominent users. The muskgrass, Chara, comprised the bulk of the algae consumed. The oogonia of the fertile Chara were eaten in great numbers. Martin and Uhler (1939) rate Chara as good to excellent. Cottam (1939) suggests that Chara is a particularly important food for diving ducks.

Insects were an important waterfowl food during the first season. Nearly one-fourth of all ducks examined from that year contained insects. Released mallards, green-wing teal, wigeons, and shovelers were principal users. The majority of the insect volume consisted of caterpillars foraged from flooded vegetation in the Flooded Fields area.

Molluscs such as snails and bivalves were important to shovelers during the second year. Molluscs received little utilization in the first year, probably due to their typical habitat being deeply submerged.

Grit and Lead Shot Analysis

Grit in wood ducks, green-wing teal, blue-wing teal, and wigeons was mostly fine sand (Table 17). Gadwalls contained fine grit exclusively. Pintails and shovelers consumed mostly medium grit. Mallards picked up mostly medium grit but also contained more coarse grit (30 percent) than any other species. All sizes of grit were available on the study area.

Anderson (1959) conducted a similar grit study on Illinois waterfowl. His results were similar except that he found pintails taking more coarse grit. He explains the frequency with which sand occurs in wigeon

Table 17. Amount and size (expressed as percent) of grit ingested by waterfowl in the 1974 and 1975 hunting seasons, Lake Somerville, Texas.

| Species | Fine[a] | Fine-Med | Med[b] | Med-Coarse | Coarse[c] | F-M-C | $\bar{x}$ cc grit | s |
|---|---|---|---|---|---|---|---|---|
| Wood Duck | 80.00 | 10.00 | 5.00 | | | 5.00 | 0.689 | 0.464 |
| All Mallards | | 5.00 | 40.00 | 25.00 | 30.00 | | 2.216 | 7.623 |
| Green-wing Teal | 68.75 | 13.55 | 12.50 | 2.08 | | 3.12 | 0.980 | 0.544 |
| Blue-wing Teal | 50.00 | 6.25 | 31.25 | 12.50 | | | 1.144 | 0.534 |
| Pintail | 9.10 | | 63.63 | 27.27 | | | 0.937 | 0.610 |
| Gadwall | 100.00 | | | | | | 3.043 | 1.230 |
| Wigeon | 83.34 | | 16.66 | | | | 0.998 | 0.864 |
| Shoveler | 7.15 | 21.42 | 64.28 | | | 7.15 | 2.082 | 0.777 |
| Others | | | 45.45 | 45.45 | | 9.10 | 2.553 | 1.688 |

[a] Fine $\leq$ 1.5mm dia.

[b] 1.5mm dia. < Medium $\leq$ 3mm dia.

[c] Coarse > 3mm dia.

and gadwall gizzards as a relationship between the food habits and physical composition of the grit ingested. He states, "baldpates and gadwalls generally feed on soft, leafy aquatic plants, which are likely to require little or no grinding during the digestive processes, and the sand recovered from the gizzards of these ducks may have been taken only because it adhered to the food; or it may have been unintentionally taken during normal feeding activity." The fact that wood ducks on Lake Somerville contained 80 percent fine sand and no coarse grit, and consumed mostly hard oak and hickory mast seems to disprove this hypothesis.

Gadwalls had the largest average volume of grit per gizzard (3.043 cc) and wood ducks had the smallest (0.689 cc). Mallards had the highest standard deviation of amount of grit consumed (7.623) and wood ducks had the lowest (0.464). Anderson (1959) found no correlation between amount of grit and size of duck, type of food, feeding habits, or feeding habitat.

Five (2.07 percent) of the 241 gizzards and crops examined contained lead shot. Three (3.09 percent) of the 97 ducks killed in the first year contained shot and 2 (1.38 percent) of the 144 ducks shot in the second year contained lead shot.

A green-wing teal, released mallard, and wild mallard each contained one lead pellet in the first season's samples. Both mallards were killed in Flag Pond and the green-wing teal was collected in the Dead Woods area. A wild mallard killed in Dead Woods area contained one pellet and a blue-wing teal killed in Flag Pond contained eight pellets in the second year's samples.

The blue-wing teal was emaciated and appeared to be suffering later

stages of lead poisoning. The shot was highly dissolved and it is thought that this bird picked up the shot somewhere other than on the study area. The bird was killed in early September and few blue-wings were present before this date.

It is likely that the other four birds ingested the shot on the study area, especially the rather immobile released mallard. Large quantities of shot are deposited yearly in Flag Pond and Dead Woods due to heavy hunting pressure. Flag Pond has been gunned over for at least 50 years. However, the shot probably remains available to the ducks only for a relatively short time because of the softness of the mud (Bellrose 1959).

Several additional gizzards contained lead pellets. Upon close examination holes were found in these gizzards and these holes proved to be entering pathways for the shot. Thus the pellets found in these gizzards were the result of direct gunfire and not of the birds' consuming spent pellets. If the careful examinations had not been employed, gross miscalculations in the amount of spent shot ingested would have occurred. This, then, raises a question of accuracy in former lead shot studies because most samples were hunter collected. If past researchers have not considered this possibility, overestimations may have resulted. Also unworn pellets do not necessarily prove that the shot was not ingested. The inclusion of only a few misinterpreted samples can seriously alter results.

## Habitat Utilization

A total of 7,461 ducks were observed on six habitat types in the

first season (Table 18). Nearly one-half of all waterfowl were observed on Flag Pond. Flooded Fields, Nail's Creek, Green Tree, Open Water, and Dead Woods received less utilization in that order. Because of the water level fluctuations and availability of the habitats the percentages in Table 16 are probably not indications of preferred habits but express degrees of utilization.

Thirty-four percent of all mallards were on Flag Pond and only 9 percent were observed in the Green Woods area. However, when sufficient water was present in the Green Woods area mallards used this habitat to a much greater extent. This response was also noted in the case of the Flooded Fields area. Twenty-one percent of all mallards were observed in the Nail's Creek region but only small numbers were sighted in the Dead Woods and Open Water areas.

Pintails appeared to prefer the Flooded Fields area because of the large number of birds sighted here during the relatively short period of time that the region was available as habitat. Most pintails utilized Flag Pond when the Flooded Fields were not available.

Most wigeons and gadwalls were observed in Flag Pond although wigeons seemed to prefer the Flooded Fields area when available. Most teal and shovelers were seen on Flag Pond but Nail's Creek received considerable utilization.

Wood ducks were found in two habitats exclusively. Nearly 88 percent were observed in the Green Tree area with the remainder sighted in the Dead Woods region.

The only species that extensively utilized the Open Water area was the lesser scaup. Sixty-five percent of all lesser scaup were observed

Table 18. Distribution (by percentage) of waterfowl on upper end of Lake Somerville, Texas, 1974-75 season.

| Species | Flag Pond | Nail's Creek | Green Tree | Dead Woods | Flooded Fields | Open Water |
|---|---|---|---|---|---|---|
| Mallard (2037) | 34.81 | 21.55 | 9.23 | 2.99 | 27.30 | 4.12 |
| Pintail (763) | 35.65 | .66 | | 2.36 | 58.98 | 2.36 |
| Wigeon (559) | 52.42 | 16.82 | | | 30.77 | |
| Gadwall (417) | 77.70 | 18.00 | | | 4.30 | |
| Blue-wing Teal (523) | 76.86 | 21.22 | | .96 | .96 | |
| Green-wing Teal (2111) | 59.12 | 19.09 | .24 | 3.88 | 17.67 | |
| Wood Duck (328) | | | 87.80 | 12.20 | | |
| Shoveler (588) | 53.91 | 19.05 | | 3.06 | 16.67 | 7.31 |
| Lesser Scaup (123) | 30.89 | 4.07 | | | | 65.04 |
| Ruddy Duck (2) | 100.00 | | | | | |
| Redhead (10) | 50.00 | | | | 50.00 | |
| Total (7461) | 48.38 | 16.67 | 6.45 | 3.00 | 22.48 | 3.02 |

in this area. Most of the remainder were counted on Flag Pond.

It is difficult to explain conclusively why the different species utilized the various habitat types in the first season. However, Flag Pond was probably utilized most because choice foods were available for the longest period of time. The Flooded Fields, although available for only short periods of time, provided a vast area of relatively remote habitat with good food sources when flooded. The Nail's Creek region offered ample food but was smaller in size. The Green Tree area received less utilization and the Dead Woods area was usually deeply flooded and offered little in the way of food or roosting sites. Similarly, the Open Water region was unattractive except to lesser scaup.

Few movements by undisturbed waterfowl for behavioral purposes were observed in the first season. Most ducks fed, loafed and roosted in the particular habitat type they were observed in. Wood ducks were the exception as they routinely moved to and from selected roosting sites. These areas were usually dense thickets of buttonbush and water elm in the Green Woods region or along Yegua Creek.

Movements due to water fluctuations and hunting pressure were common. Ducks moved into the Flooded Fields region following heavy rains and gradually moved out as the water level fell. Likewise, the total number of ducks observed on Flag Pond was higher at high lake elevations (Fig. 3). Mallards and wood ducks in particular responded to the presence of water in the Green Woods area. As hunting pressure increased ducks moved into areas less accessible to hunters, usually Flooded Fields or the Green Tree area if available. Many birds left the study area entirely and returned after the close of legal shooting hours

(sunset). On several occasions during the hunting season, large numbers of ducks were observed dropping onto Flag Pond just at darkness.

The Flooded Fields and Green Woods areas, except for the Yegua Creek channel, were not available as waterfowl habitat during the second season of study. Lake elevations were low and habitat sizes were constant. A more accurate picture of habitat selection can be drawn from this year's data. The Chi square analysis revealed selection among all species tested (Table 19). Significance was determined from both methods of calculating expected values although the surface area method gave much higher Chi square values. The shoreline expected value is probably more realistic because of the habits of the species tested, i.e. all were puddle ducks.

A total of 8,941 ducks were observed in the second season's surveys (Table 20). The Dead Woods area, which received the least utilization in the previous year, was used most in the second year. Nearly 45 percent of all ducks were observed in the Dead Woods region. Flag Pond, Nail's Creek, Open Water and Yegua Creek were less utilized in that order.

Mallards were found in all types but seemed to have a definite preference for the Dead Woods area. Mallards selected against the Nail's Creek region as only two were observed in this type.

From field observations, pintails and gadwalls seemed to prefer Flag Pond. Pintails are thought to select against the Dead Woods area. Wigeons appeared to select for Nail's Creek and Dead Woods but against Flag Pond. Blue-wing teal and green-wing teal seemed to prefer the Dead Woods area. Shovelers appeared to select for Nail's Creek.

Wood ducks selected for the Dead Woods area as 97 percent were

Table 19. Waterfowl selection within three habitat types on Lake Somerville, Texas, 1975-76.

| Species | Flag Pond | Nail's Creek | Dead Woods | $X^2$ |
|---|---|---|---|---|
| All Species | | | | |
| Expected (surface)[a] | 6944 | 528 | 1329 | 9527 |
| Expected (shore)[b] | 4101 | 1707 | 2983 | 567 |
| Observed | 3208 | 1571 | 4022 | |
| Mallard | | | | |
| Expected (surface) | 1130 | 86 | 216 | 5017 |
| Expected (shore) | 667 | 278 | 485 | 1510 |
| Observed | 255 | 2 | 1175 | |
| Pintail | | | | |
| Expected (surface) | 817 | 62 | 156 | 343 |
| Expected (shore) | 214 | 89 | 351 | 236 |
| Observed | 580 | 155 | 301 | |
| Wigeon | | | | |
| Expected (surface) | 362 | 28 | 69 | 1330 |
| Expected (shore) | 214 | 89 | 156 | 236 |
| Observed | 50 | 155 | 301 | |
| Gadwall | | | | |
| Expected (surface) | 1554 | 118 | 297 | 1083 |
| Expected (shore) | 918 | 382 | 667 | |
| Observed | 1010 | 396 | 563 | |
| Blue-wing Teal | | | | |
| Expected (surface) | 352 | 27 | 67 | 479 |
| Expected (shore) | 208 | 87 | 151 | 18 |
| Observed | 165 | 93 | 188 | |
| Green-wing Teal | | | | |
| Expected (surface) | 2321 | 177 | 444 | 3565 |
| Expected (shore) | 1371 | 571 | 997 | 176 |
| Observed | 1018 | 661 | 1263 | |
| Shoveler | | | | |
| Expected (surface) | 204 | 15 | 39 | 283 |
| Expected (shore) | 120 | 50 | 87 | 18 |
| Observed | 120 | 74 | 64 | |

[a] Expected value determined by amount of water surface area in each habitat type.

[b] Expected value determined by amount of shoreline in each habitat type.

Table 20. Distribution (by percentage) of waterfowl on upper end of Lake Somerville, Texas, 1975-76 season.

| Species | Flag Pond | Nail's Creek | Yegua Creek[a] | Dead Woods | Flooded Fields[b] | Open Water |
|---|---|---|---|---|---|---|
| Mallard (1444) | 17.66 | .14 | .48 | 81.37 | | .35 |
| Pintail (1044) | 55.56 | 14.85 | | 28.83 | | 7.66 |
| Wigeon (459) | 10.89 | 33.12 | | 55.99 | | |
| Gadwall (2007) | 50.32 | 19.73 | | 28.05 | | 1.89 |
| Blue-wing Teal (446) | 37.00 | 20.85 | | 42.15 | | |
| Green-wing Teal (2942) | 34.60 | 22.47 | | 42.93 | | |
| Wood Duck (217) | | | 2.76 | 97.24 | | |
| Shoveler (258) | 46.51 | 28.68 | | 24.81 | | |
| Lesser Scaup (119) | 4.20 | 31.93 | | | | 63.87 |
| Ruddy Duck (5) | 100.00 | | | | | |
| Total (8941) | 35.88 | 17.57 | .15 | 44.98 | | 1.42 |

[a]Only the Yegua Creek protion of the Green Tree area was available as habitat in this season.

[b]Flooded Fields not available as waterfowl habitat.

observed in this type. The remainder were counted on Yegua Creek. Lesser scaup were again the only species to prefer Open Water. The scaups utilized Flag Pond less and Nail's Creek more in the second year. Ruddy ducks and divers other than scaup utilized Flag Pond most in both seasons of study.

The attraction of the Dead Woods area greatly increased in the second season of study. Low lake elevations afforded a great amount of shoreline and abundant food supply. The abundance of logs and stumps furnished almost unlimited loafing spots. This characteristic was probably one of the most important factors making the area attractive to ducks (Cowardin 1969, Sowls 1955).

Flag Pond was smaller and supported less waterfowl food in the second season. Nail's Creek was smaller but was still utilized by nearly the same percentage of waterfowl as in the previous year. The large amount of shoreline in the Nail's Creek region seemed to attract the ducks.

Movements for specific behavioral traits were more evident during the second season. Green-wing teal were observed to feed in the Nail's Creek area and then fly to the Dead Woods region to loaf during the day. Other species were commonly observed loafing in the Dead Woods area. This type was used as a communal roost by several species in the second year. The low lake levels forced the wood ducks to change habits and to roost in the brushier areas of Dead Woods.

No movements due to weather were observed in the second season, however waterfowl were again affected by hunting pressure. No areas inaccessible to hunters were available to the ducks on the study area and

consequently the birds frequently left. Many went to other parts of the reservoir and returned at night. Large numbers of ducks were observed feeding on Flag Pond before daylight on two occasions; none were present the previous evening at sunset.

Released Mallards

Sightings of the released mallards were common in the summer and early fall of 1974. Most inhabited Flag Pond until the opening of the special teal season. They tended to stay in one large flock and could be identified by the presence of leg bands as they loafed on logs or the shore.

Some released mallards were known to have been killed in the early teal season. After the initial teal season, the released mallards dispersed throughout the study area and onto the remainder of the reservoir. A large percentage of the population was probably shot in the opening days of the regular duck season of that year because they were relatively tame and decoyed well. Of 23 mallards collected for this study in 1974, 12 were released birds. Most of the released mallards in this study were collected in the Flooded Fields area. No positive sightings of released mallards were noted in 1975-76 and none were collected in that year. It is improbable that many of the ducks survived the first year and even less likely that successful reproduction occurred. Kiel (1970), in a similar study, recorded a first year mortality rate of 74 percent. Nest-destroying predators were common on the study area. A minimum of 30 raccoons (Procyon lotor) were observed on this area within a 3 hour period of time in 1974. Kiel also noted almost complete destruction of

mallard ground nests in south Texas.

From the observations made on Lake Somerville, it does not seem feasible to attempt future projects of this nature under similar conditions. Money and time could be better spent improving the available habitat for wild waterfowl. However if such attempts are to be made, severe hunting restrictions, until the population is well established, and construction of predator-proof, artificial nesting structures should be considered.

## CONCLUSIONS

1. The different habitat types found on most southern reservoirs can vary in their attractiveness among different duck species.

2. Extreme fluctuations in reservoir elevations, particularly in summer months, can drastically alter the stand and composition of waterfowl attracting vegetation.

3. Waterfowl food habits on reservoirs can change dramatically from one year to the next due in part to extreme fluctuations of water levels in summer months and also to fall and winter water elevations. Waterfowl will readily switch from one major food source to another.

4. There can be occasions when optimum water depths for feeding puddle ducks is as much as 1 m. This depends on the type and growing habits of the vegetation consumed.

5. The food habits and behavior of wild mallards and pen-reared released mallards are substantially different.

6. The gizzards and esophagi of wood ducks and wild mallards tend to contain a larger volume of food items than those of some other luck species.

7. Grit size in waterfowl is not necessarily determined by the type or hardness of the food item consumed.

8. Some previous lead-shot studies may contain over-estimates of lead ingestion due to the investigators' not carefully examining the source of the shot in the gizzard.

9. It appears unfeasible to attempt stocking pen-reared mallards for the purpose of establishing local breeding populations on southern reservoirs.

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# VITA

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